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BROOME, SAID A	

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Please find below and/or attached an Office communication concerning this application or proceeding.

The time period for reply, if any, is set in the attached communication.

Office Action Summary	Application No. 10/539,387	Applicant(s) GERRITSEN ET AL.	
	Examiner SAID BROOME	Art Unit 2628	

-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address --

Period for Reply

A SHORTENED STATUTORY PERIOD FOR REPLY IS SET TO EXPIRE 3 MONTH(S) OR THIRTY (30) DAYS, WHICHEVER IS LONGER, FROM THE MAILING DATE OF THIS COMMUNICATION.

- Extensions of time may be available under the provisions of 37 CFR 1.136(a). In no event, however, may a reply be timely filed after SIX (6) MONTHS from the mailing date of this communication.
- If NO period for reply is specified above, the maximum statutory period will apply and will expire SIX (6) MONTHS from the mailing date of this communication.
- Failure to reply within the set or extended period for reply will, by statute, cause the application to become ABANDONED (35 U.S.C. § 133). Any reply received by the Office later than three months after the mailing date of this communication, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

Status

1)☒ Responsive to communication(s) filed on 22 December 2009.

2a)☐ This action is **FINAL**. 2b)☒ This action is non-final.

3)☐ Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11, 453 O.G. 213.

Disposition of Claims

4)☒ Claim(s) 1-9 and 11-21 is/are pending in the application.

4a) Of the above claim(s) _____ is/are withdrawn from consideration.

5)☒ Claim(s) 6 is/are allowed.

6)☒ Claim(s) 1-3,5,7,8,10,11,13,14 and 21 is/are rejected.

7)☒ Claim(s) 4,9,12 and 15-20 is/are objected to.

8)☐ Claim(s) _____ are subject to restriction and/or election requirement.

Application Papers

9)☐ The specification is objected to by the Examiner.

10)☐ The drawing(s) filed on _____ is/are: a)☐ accepted or b)☐ objected to by the Examiner.

Applicant may not request that any objection to the drawing(s) be held in abeyance. See 37 CFR 1.85(a).

Replacement drawing sheet(s) including the correction is required if the drawing(s) is objected to. See 37 CFR 1.121(d).

11)☐ The oath or declaration is objected to by the Examiner. Note the attached Office Action or form PTO-152.

Priority under 35 U.S.C. § 119

12)☒ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).

a)☒ All b)☐ Some * c)☐ None of:

1.☒ Certified copies of the priority documents have been received.

2.☐ Certified copies of the priority documents have been received in Application No. _____.

3.☐ Copies of the certified copies of the priority documents have been received in this National Stage application from the International Bureau (PCT Rule 17.2(a)).

* See the attached detailed Office action for a list of the certified copies not received.

Attachment(s)

1) ☐ Notice of References Cited (PTO-892)

2) ☐ Notice of Draftsperson's Patent Drawing Review (PTO-948)

3) ☐ Information Disclosure Statement(s) (PTO/SB/08) Paper No(s)/Mail Date _____.

4) ☐ Interview Summary (PTO-413) Paper No(s)/Mail Date. _____.

5) ☐ Notice of Informal Patent Application

6) ☐ Other: _____.

DETAILED ACTION

Response to Amendment

1. This office action is in response to an amendment filed on 12/22/2009.
2. Claims 1, 6, 13 and 14 have been amended by the applicant.
3. Claims 2-5, 7-9, 11, 12 and 15-20 are original.
4. Claim 10 has been cancelled.
5. Claim 21 has been added.

Claim Objections

Claim 21 is objected to under 37 CFR 1.75(c), as being of improper dependent form for failing to further limit the subject matter of claim 14. Applicant is required to cancel the claim(s), or amend the claim(s) to place the claim(s) in proper dependent form, or rewrite the claim(s) in independent form.

Claim Rejections - 35 USC § 101

35 U.S.C. 101 reads as follows:

> Whoever invents or discovers any new and useful process, machine, manufacture, or composition of matter, or any new and useful improvement thereof, may obtain a patent therefor, subject to the conditions and requirements of this title.

Claim 13 is rejected under 35 U.S.C. 101 because claim 13 recites: "*A tangible computer readable storage medium storing a computer program…*", however, the ordinary meaning of a computer readable storage medium known in the art covers forms of non-transitory mediums(CD-ROM, hard rives, etc.) and transitory mediums (propagating signals, etc.), therefore claim 13 is not statutory for reciting a computer readable medium which covers both

non-statutory subject matter and statutory subject matter. However, claim 13 may be amended to narrow the claim to cover only statutory embodiments by amending the claim to recite "*A non-transitory tangible computer readable storage medium storing a computer program…*". Claims that recite nothing but the physical characteristics of a form of energy, such as a frequency, voltage, or the strength of a magnetic field, define energy or magnetism, per se, and as such are nonstatutory natural phenomena. O'Reilly*,* 56 U.S. (15 How.) at 112-14. Moreover, it does not appear that a claim reciting a signal encoded with functional descriptive material falls within any of the categories of patentable subject matter set forth in § 101. First, a claimed signal is clearly not a "process" under § 101 because it is not a series of steps. The other three § 101 classes of machine, compositions of matter and manufactures "relate to structural entities and can be grouped as 'product' claims in order to contrast them with process claims." 1 D. Chisum, Patents § 1.02 (1994). The three product classes have traditionally required physical structure or material.

Claim Rejections - 35 USC § 103

The following is a quotation of 35 U.S.C. 103(a) which forms the basis for all obviousness rejections set forth in this Office action:

> (a) A patent may not be obtained though the invention is not identically disclosed or described as set forth in section 102 of this title, if the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art to which said subject matter pertains. Patentability shall not be negatived by the manner in which the invention was made.

Claims 1-3, 5, 7, 8, 11, 13, 14 and 21 are rejected under 35 U.S.C. 103(a) as being unpatentable over Argiro et al. (hereinafter "Argiro", U.S. Patent 5,986,662) in view of Kaufman

et al. (hereinafter "Kaufman", US 2004/0125103) and in further view of Buehler (US 2003/0160788).

Regarding claim 1, Argiro teaches a system for visualizing a three-dimensional (hereinafter "3D") volume, in particular for medical applications (col. 6 lines 19-28: "*The Advanced Diagnostic Viewer (ADV) is a three-dimensional medical imaging workstation, comprised of software running on general-purpose, high-performance three-dimensional graphics hardware. The invention provides both a two-dimensional and a three-dimensional environment in which to view voluminous data organized into a plurality of voxels, each voxel having at least a voxel value. One particular embodiment of the invention provides a diagnostic environment for medical professionals such as radiologists.*" *and is illustrated in Fig. 1: 100*); the system including:

an input for receiving a three-dimensional set of data representing voxel values of the 3D volume (col. 4 lines 9-11: "*The retrieve data set component permits a user to load a previously acquired set of voxel data.*");

a storage which stores the medical image data set (col. 30 lines 63-64: "*...the set of voxel data from a storage device...*" and Fig. 3: *120*);

an output which provides pixel values of a two-dimensional (hereinafter "2D") image representation for rendering (col. 3 lines 10-11: "*...to produce image pixels for display on a computer screen.*"); and

a processor which, under control of a computer program, processes the medical image data set to obtain the 2D image representation (col. 6 lines 19-28: "*The Advanced Diagnostic Viewer (ADV) is a <u>three-dimensional medical imaging workstation, comprised of software</u>*

<u>running on general-purpose, high-performance three-dimensional graphics hardware</u>. The invention provides both a two-dimensional and a three-dimensional environment in which to view voluminous <u>data organized into a plurality of voxels</u>, each voxel having at least a voxel value ", *in which the software, or computer program product, causes the general-purpose graphic hardware to display three-dimensional data on a workstation, in which the hardware thereby comprises a processor to implement this display process*) by performing the steps of:

casting a ray from each pixel of the 2D image representation through the volume (col. 3 lines 1-4: "*...ray casting, the volume is positioned behind the picture plane, and a ray is projected perpendicularly from each pixel in the picture plane through the volume behind the pixel.*");

traversing along the ray through at least a plurality of ray positions within the volume (col. 2 line 63 - col. 2 line 8: "*In one method of voxel rendering, called image ordering or ray casting, the volume is positioned behind the picture plane, and a ray is projected perpendicularly from each pixel in the picture plane through the volume behind the pixel. As each ray penetrates the volume, it accumulates the properties of the voxels it passes through and adds them to the corresponding pixel. The properties accumulate more quickly or more slowly depending on the transparency of the voxels.*" and col. 4 lines 11-16: "*...a protocol that includes preset adjustments for the volume-rendering of the data, based on the type of data that was loaded via the retrieve data set component. This protocol allows for an initial volume-rendering of the data that is logical in light of the type of data.*", *in which a ray is cast through portions of volume data with respect to a volume rendering protocol which renders the volume using corresponding penetrated positions of the ray as it traverses the volume*); and

However, Argiro fails to teach selecting one of a plurality of rendering algorithms and/or rendering parameters, in dependence on the ray position, the selected one of the plurality of rendering algorithms and/or rendering parameters changing with the ray position, the selected rendering algorithm and/or rendering parameter being different for some of the ray positions of the 2D image than for other ray positions of said 2D image, for each of the plurality of ray positions, calculating a contribution to a corresponding pixel value based on at least one voxel value within a predetermined range of the ray position using the selected one of the rendering algorithms and/or rendering parameters for each of the ray positions. Kaufman teaches for each of the plurality of ray positions, calculating a contribution to a corresponding pixel value based on at least one voxel value within a predetermined range of the ray position using the selected one of the rendering algorithms and/or rendering parameters for each of the ray positions (¶0008 lines 3-14: "*Volume rendering is one of the most common techniques for visualizing the 3D scalar field of a continuous object or phenomenon represented by voxels at the grid points of the volume dataset…rays are cast from screen pixels through the volume dataset, and contributions of voxels along these sight rays are used to evaluate the corresponding pixel values.*" and ¶0021 lines 1-12: "*…the present invention is a method and apparatus for performing approximate perspective volumetric ray casting of a three-dimensional (3D) volume dataset…The length of the volume dataset is calculated between the location of the nearest voxel to the viewpoint and the farthest voxel from the viewpoint.*", *in which rays are cast through a volume to produce a contributing pixel value within the entire volume dataset by penetrating the range and length of the dataset, using a selected rendering parameter, such as an approximate perspective ray casting*). Therefore it would have been obvious to one skilled in the art at the time of invention to

modify the volume rendering of Argiro with the calculated contributing pixel values of Kaufman because this modification ensures correct display of a volume data set through providing a rendering algorithm enabling the contributing pixel value of each corresponding ray to be calculated as it traverses through a range of the data set to provide accurate representation of the volume on a display screen.

However, Argiro and Kaufman fail to teach selecting one of a plurality of rendering algorithms and/or rendering parameters, in dependence on the ray position, the selected one of the plurality of rendering algorithms and/or rendering parameters changing with the ray position, the selected rendering algorithm and/or rendering parameter being different for some of the ray positions of the 2D image than for other ray positions of said 2D image. Buehler teaches selecting one of a plurality of rendering algorithms and/or rendering parameters, in dependence on the ray position, the selected one of the plurality of rendering algorithms and/or rendering parameters changing with the ray position (¶0047 lines 3-5: "*…voxel ray tracers are preferably configured to conduct perspective ray tracing where the rays diverge with each cast.*", *in which a rendering parameter, such as implementation of a perspective ray tracing, is implemented based on the bundled position of the rays, in which the perspective ray tracing rendering parameters are executed in response to determination of ray whose positions have changed or diverged, in to a ray bundle*, ¶0015 lines 8-11) the selected rendering algorithm and/or rendering parameter being different for some of the ray positions of the 2D image than for other ray positions of said 2D image (¶0143 lines 1-2: "*The bundle caster 910 recursively advances a position 914 of a ray bundle.*", ¶0144 lines 1-4: "*…the bundle caster provides an individual ray 912 to the ray caster 930.*" and ¶0145 lines 5-8: "*…position 914 that is advanced by the bundle*

caster 910 and the position 932 that is advanced by the ray caster 930 each have a depth component that corresponds to a pixel depth within the graphical scene 150.", *in which a selected rendering algorithm, such as ray casting or ray bundle casting, is performed with respect to the position of the rays, whether in an individual or bundled position for pixels that thereby reside within a two dimensional image*). Therefore it would have been obvious to one skilled in the art at the time of invention to modify the volume rendering of Argiro and contributing pixel values of Kaufman with the selected rendering parameters of Buehler because this modification would enable efficient rendering of a volume data set through providing particular rendering parameters based on certain positions of the ray as is traverse through data, thereby improving rendering accuracy of the data traversed by the ray by enabling parameters of the rendering to be provided in response to the position of the ray.

Regarding claim 2, Argiro teaches the wherein the selecting of one of the plurality of rendering algorithms and/or rendering parameters is based on a-priori knowledge of at least one of the following: the volume, the medical situation, the clinical situation based on at least one of anatomical, medical and clinical knowledge of a medical expert (col. 4 lines 11-16: "...*a protocol that includes preset adjustments for the volume-rendering of the data, based on the type of data that was loaded via the retrieve data set component. This protocol allows for an initial volume-rendering of the data that is logical in light of the type of data.*" and col. 10 lines 43-45: "...*the protocols are generated a priori by clinical testing to determine the most appropriate presets for a particular data set.*").

Regarding claim 3, Argiro and Kaufman fail to teach further including a 3D model of at least one object in the volume, the used one of the plurality of rendering algorithms and/or

rendering parameters being selected in accordance with a relationship between each ray position and the at least one object of the 3D model. Buehler teaches further including a 3D model of at least one object in the volume, the used one of the plurality of rendering algorithms and/or rendering parameters being selected in accordance with a relationship between each ray position and the at least one object of the 3D model (¶0047 lines 3-5: "*...voxel ray tracers are preferably configured to conduct perspective ray tracing where the rays diverge with each cast.*", *in which a rendering parameter, such as implementation of a perspective ray tracing, is implemented based on the bundled position of the rays, in relation to a 3D model, Fig. 1a, in which the perspective ray tracing rendering parameters are executed in response to determination of ray whose positions have changed or diverged, in to a ray bundle*). Therefore it would have been obvious to one skilled in the art at the time of invention to modify the volume rendering of Argiro and contributing pixel values of Kaufman with the selected rendering parameters of Buehler because this modification would enable efficient rendering of a volume data set through providing particular rendering parameters based on certain positions of the ray as is traverse through data, thereby improving rendering accuracy of the data traversed by the ray by enabling parameters of the rendering to be provided in response to the position of the ray.

Regarding claim 5, Argiro teaches a rule prescribes for each of the plurality of ray positions at least one processing action at least in dependence on processing results of ray position along the ray that already been processed (col. 3 lines 1-8: "*...ray casting, the volume is positioned behind the picture plane, and a ray is projected perpendicularly from each pixel in the picture plane through the volume behind the pixel. As each ray penetrates the volume, it accumulates the properties of the voxels it passes through...The properties accumulate more*

quickly or more slowly depending on the transparency of the voxels.", *in which a ray processes results of the ray at positions that have already been processed using an accumulation processing action of the volume rendering protocol*).

Regarding claim 7, Argiro teaches a storage which stores a plurality of protocols for controlling the traversing along the ray (col. 11 lines 7-17: "*...there are 1-N protocols 186, where N is the number of protocols 186...The external configuration file specifies which protocol selector fields are to be matched with which protocol names.*", col. 10 lines 51-53: "*Protocols thus include presets for the visual controls governing the viewing of the volume-rendering of the voxel data...*" and in col. 3 lines 1-4: "*...volume rendering is the use of the entire voxel data set to create an image. In one method of voxel rendering, called...ray casting, the volume is positioned behind the picture plane, and a ray is projected perpendicularly from each pixel in the picture plane through the volume behind the pixel.*", *where a plurality of protocols are stored, such as the volume rendering protocol for implementing ray traversal*).

Regarding claim 8, Argiro teaches wherein the storage includes a plurality of predetermined protocols which control the selection of the rendering algorithm and/or rendering parameters, each of the protocols corresponding to one of a plurality of anatomical regions of the patient (col. 11 lines 7-17: "*...there are 1-N protocols 186, where N is the number of protocols 186...The external configuration file specifies which protocol selector fields are to be matched with which protocol names.*" and col. 4 lines 11-16 and 25-29: "*...a protocol that includes preset adjustments for the volume-rendering of the data, based on the type of data that was loaded via the retrieve data set component. This protocol allows for an initial volume-rendering of the data that is logical in light of the type of data...also providing different presets of those controls that*

correspond to particular types of anatomical or other data that is commonly encountered.", *in which the protocol file includes a plurality of protocols, which are preset or pre-designated for a related type of data, such as a anatomical region*).

Regarding claim 11, Argiro teaches the computer program is operative to cause the processor to enable a human operator to select at least one protocol form the plurality of stored protocols for processing the volume (col. 12 lines 41-55: "*A user, such as a radiologist or a technician, changes the pre-selected protocol by selecting one of the alternatives 214, which then becomes protocol 212.*"); and store a selection of the human operator in association with an identity of the operator for subsequent retrieval (col. 12 lines 41-55: "*...current protocol 212 initially shows the pre-selected protocol...A user, such as a radiologist or a technician, changes the pre-selected protocol by selecting one of the alternatives 214, which then becomes protocol 212.*", *in which the protocol component of the system, as shown in Fig. 2: 110, enables subsequent user change of pre-selected protocols to a new protocol, in which each of the protocols are retrieved from a plurality of protocols stored in a file,* col. 11 lines 7-17: "*...there are 1-N protocols 186, where N is the number of protocols 186...The external configuration file specifies which protocol selector fields are to be matched with which protocol names.*", *where the system would consequently contain a processing unit to implement the software to of the protocol component to enable subsequent retrieval of user selection and modification to the protocols*).

Regarding claim 13, Argiro teaches a tangible computer readable storage medium storing a computer program for causing a processor to process a three-dimensional set of data representing voxel values of a 3D volume (col. 6 lines 19-28: "*The Advanced Diagnostic Viewer*

(ADV) is a <u>*three-dimensional medical imaging workstation, comprised of software running on general-purpose, high-performance three-dimensional graphics hardware*</u>. *The invention provides both a two-dimensional and a three-dimensional environment in which to view voluminous* <u>*data organized into a plurality of voxels*</u>*, each voxel having at least a voxel value* " *and shown in* Fig. 3: *108, in which the software, or computer program, causes the general-purpose graphic hardware to process three-dimensional data, in which the hardware thereby comprises a medium readable by that hardware to use the processor to implement this process*) depicting an anatomical region of a patient (Fig. 3: *122*) to obtain a 2D image having a plurality of pixels of the 3D volume by projecting the 3D volume onto an imaginary 2D projection screen (col. 4 lines 17-34: "*The image gallery component displays these initial volume-rendered images of the data…the user in more particular is able to refine the view or views of the selected image. The examination viewer component provides the user with exacting controls in the viewing of the image…The examination viewer component also allows the user to fly around and through the data, to obtain the correct view sought. The user is able to select a number of snapshots of such views, or create a video recording of the views. The report generator/viewer component permits the user to assemble these views…*" and col. 14 lines 25-32: "*…viewer component 114 permits display of an image of a patient's data with selected settings by volume view and…by inside view, outside view, and MPR orthogonal or oblique views; and, by volume view only, which is a large three-dimensional rendering.*", *where the volume data is projected onto a display to obtain a two-dimensional representation on a screen from a defined point of view*) by controlling the processor to perform the steps of:

from a memory which stores a plurality of rendering algorithms/parameters, selecting a subset of the rendering algorithm/parameters in accordance with an anatomical region depicted by the 3D volume (col. 11 lines 7-17: "*...there are 1-N protocols 186, where N is the number of protocols 186...The external configuration file specifies which protocol selector fields are to be matched with which protocol names.*" and col. 4 lines 11-16 and 25-29: "*...a protocol that includes preset adjustments for the volume-rendering of the data, based on the type of data that was loaded via the retrieve data set component. This protocol allows for an initial volume-rendering of the data that is logical in light of the type of data...also providing different presets of those controls that correspond to particular types of anatomical or other data that is commonly encountered.*");

casting a ray through each pixel of the 2D image and into the 3D volume (col. 3 lines 1-4: "*...ray casting, the volume is positioned behind the picture plane, and a ray is projected perpendicularly from each pixel in the picture plane through the volume behind the pixel.*"); and

stepping along the ray through at least a plurality of ray positions within the volume under control of a protocol that selects one of the subset of rendering algorithms/parameters for each ray position (col. 2 line 63 - col. 2 line 8: "*In one method of voxel rendering, called image ordering or ray casting, the volume is positioned behind the picture plane, and a ray is projected perpendicularly from each pixel in the picture plane through the volume behind the pixel. As each ray penetrates the volume, it accumulates the properties of the voxels it passes through and adds them to the corresponding pixel. The properties accumulate more quickly or more slowly depending on the transparency of the voxels.*" and col. 4 lines 11-16: "*...a protocol that includes preset adjustments for the volume-rendering of the data, based on the type of data that was*

loaded via the retrieve data set component. This protocol allows for an initial volume-rendering of the data that is logical in light of the type of data.", *in which a ray is cast through portions of volume data with respect to the volume rendering protocol which renders the volume using corresponding penetrated positions of the ray as it traverses the volume*);

However, Argiro fails to teach the rendering algorithm/parameters selected for some ray positions being different than the rendering algorithm/parameters selected for other ray positions, for each of the plurality of ray positions using the selected rendering algorithm/parameter to calculate a contribution to a pixel value of the pixel corresponding to the ray based on at least one voxel value within a predetermined range of the ray position and wherein a plurality of different rendering algorithms/parameters are used to generate the pixel values of the 2D image from the voxels of the 3D volume. Kaufman teaches for each of the plurality of ray positions using the selected rendering algorithm/parameter to calculate a contribution to a pixel value of the pixel corresponding to the ray based on at least one voxel value within a predetermined range of the ray position (¶0008 lines 3-14: "*Volume rendering is one of the most common techniques for visualizing the 3D scalar field of a continuous object or phenomenon represented by voxels at the grid points of the volume dataset…rays are cast from screen pixels through the volume dataset, and contributions of voxels along these sight rays are used to evaluate the corresponding pixel values.*" and ¶0021 lines 1-12: "*…the present invention is a method and apparatus for performing approximate perspective volumetric ray casting of a three-dimensional (3D) volume dataset…The length of the volume dataset is calculated between the location of the nearest voxel to the viewpoint and the farthest voxel from the viewpoint.*", *in which rays are cast through a volume to produce a contributing pixel value within the entire volume dataset by*

penetrating the range and length of the dataset), therefore it would have been obvious to one of ordinary skill in art at the time of invention to modify the volume rendering of Argiro with the calculated contributing pixel values of Kaufman because this modification ensures correct display of a volume data set through providing a rendering algorithm that enables the contributing pixel value of each corresponding ray to be calculated as it traverses through an entire range of the data set to provide accurate representation of the range of the volume on a display screen.

However, Argiro and Kaufman fail to teach the rendering algorithm/parameters selected for some ray positions being different than the rendering algorithm/parameters selected for other ray positions, and wherein a plurality of different rendering algorithms/parameters are used to generate the pixel values of the 2D image from the voxels of the 3D volume. Buehler teaches the rendering algorithm/parameters selected for some ray positions being different than the rendering algorithm/parameters selected for other ray positions (¶0143 lines 1-2: "*The bundle caster 910 recursively advances a position 914 of a ray bundle.*", ¶0144 lines 1-4: "*...the bundle caster provides an individual ray 912 to the ray caster 930.*" and ¶0145 lines 5-8: "*...position 914 that is advanced by the bundle caster 910 and the position 932 that is advanced by the ray caster 930 each have a depth component that corresponds to a pixel depth within the graphical scene 150.*", *in which a selected rendering algorithm, such as ray casting or ray bundle casting, is performed with respect to the position of the rays, whether in an individual or bundled position for pixels, that thereby reside within a two dimensional image*), and wherein a plurality of different rendering algorithms/parameters are used to generate the pixel values of the 2D image from the voxels of the 3D volume (¶0022 lines 1-8: "*Ray casting is a method to determine visible objects*

and pixels within a graphical scene 150 as shown in FIG. 1a. Ray casting is one method of conducting ray tracing that advances (casts) one ray for each pixel within the graphical scene 150 from the perspective viewer 106. With each cast one or more graphical objects are tested against each ray to see if the ray has "collided" with the object..." and ¶0047 lines 3-5: "*...voxel ray tracers are preferably configured to conduct perspective ray tracing where the rays diverge with each cast.*", *in which different rendering parameters are utilized, such as traditional ray casting, and perspective ray tracing rendering*). Therefore it would have been obvious to one skilled in the art at the time of invention to modify the volume rendering of Argiro and contributing pixel values of Kaufman with the selected rendering parameters of Buehler because this modification would enable efficient rendering of a volume data set through providing particular rendering parameters based on certain positions of the ray as is traverse through data, thereby improving rendering accuracy of the data traversed by the ray by enabling parameters of the rendering to be provided in response to the position of the ray.

Regarding claim 14, Argiro teaches a method of visualizing a 3D volume by processing a three-dimensional set of data representing an anatomical region of a patient (Fig.3: *122*), which 3D volume is defined by a three-dimensional set of data representing voxel values of a 3D array of voxels of the 3D volume (col. 2 line 67 - col. 3 line 4: "*In one method of voxel rendering...or ray casting, the volume is positioned behind the picture plane, and a ray is projected perpendicularly from each pixel in the picture plane through the volume behind the pixel.*"), as a 2D image defined by pixel values of a 2D array of pixels of a 2D image on an imaginary 2D projection screen (col. 4 lines 17-34: "*The image gallery component displays these initial volume-rendered images of the data...the user in more particular is able to refine the view or*

views of the selected image. The examination viewer component provides the user with exacting controls in the viewing of the image…The examination viewer component also allows the user to fly around and through the data, to obtain the correct view sought. The user is able to select a number of snapshots of such views, or create a video recording of the views. The report generator/viewer component permits the user to assemble these views…", *where the volume data is projected onto a display to obtain a two-dimensional representation on a screen*), the method comprising:

casting a ray through each pixel of the 2D image and into the 3D volume (col. 3 lines 1-4: "*…ray casting, the volume is positioned behind the picture plane, and a ray is projected perpendicularly from each pixel in the picture plane through the volume behind the pixel.*"); and

stepping along the ray through at least a plurality of ray positions within the volume under control of a protocol that selects one of the subset of rendering algorithms/parameters in dependence on the ray position (col. 2 line 63 - col. 2 line 8: "*In one method of voxel rendering, called image ordering or ray casting, the volume is positioned behind the picture plane, and a ray is projected perpendicularly from each pixel in the picture plane through the volume behind the pixel. As each ray penetrates the volume, it accumulates the properties of the voxels it passes through and adds them to the corresponding pixel. The properties accumulate more quickly or more slowly depending on the transparency of the voxels.*" and col. 4 lines 11-16: "*…a protocol that includes preset adjustments for the volume-rendering of the data, based on the type of data that was loaded via the retrieve data set component. This protocol allows for an initial volume-rendering of the data that is logical in light of the type of data.*", *in which a ray is cast through*

portions of volume data with respect to the volume rendering protocol which renders the volume using corresponding penetrated positions of the ray as it traverses the volume); and

at least one of displaying (Fig. 10: *208*) and storing the 2D image (Fig. 9: *112*);

However, Argiro fails to teach for some of the ray positions, different rendering algorithm/parameters are selected than for other ray positions, for each of the plurality of ray positions using the selected rendering algorithm/parameter to calculate a contribution to a pixel value of the pixel corresponding to the ray based on at least one voxel value within a predetermined range of the ray position and wherein a plurality of different rendering algorithms/parameters are used to generate the pixel values of the 2D image from the voxels of the 3D volume. Kaufman teaches for each of the plurality of ray positions using the selected rendering algorithm/parameter to calculate a contribution to a pixel value of the pixel corresponding to the ray based on at least one voxel value within a predetermined range of the ray position (¶0008 lines 3-14: "*Volume rendering is one of the most common techniques for visualizing the 3D scalar field of a continuous object or phenomenon represented by voxels at the grid points of the volume dataset...rays are cast from screen pixels through the volume dataset, and contributions of voxels along these sight rays are used to evaluate the corresponding pixel values.*" and ¶0021 lines 1-12: "*...the present invention is a method and apparatus for performing approximate perspective volumetric ray casting of a three-dimensional (3D) volume dataset...The length of the volume dataset is calculated between the location of the nearest voxel to the viewpoint and the farthest voxel from the viewpoint.*", *in which rays are cast through a volume to produce a contributing pixel value within the entire volume dataset by penetrating the range and length of the dataset*), therefore it would have been obvious to one of

ordinary skill in art at the time of invention to modify the volume rendering of Argiro with the calculated contributing pixel values of Kaufman because this modification ensures correct display of a volume data set through providing a rendering algorithm that enables the contributing pixel value of each corresponding ray to be calculated as it traverses through an entire range of the data set to provide accurate representation of the range of the volume on a display screen. However, Argiro and Kaufman fail to teach for some of the ray positions, different rendering algorithm/parameters are selected than for other ray positions. Buehler teaches for some of the ray positions, different rendering algorithm/parameters are selected than for other ray positions (¶0143 lines 1-2: "*The bundle caster 910 recursively advances a position 914 of a ray bundle.*", ¶0144 lines 1-4: "*...the bundle caster provides an individual ray 912 to the ray caster 930.*" and ¶0145 lines 5-8: "*...position 914 that is advanced by the bundle caster 910 and the position 932 that is advanced by the ray caster 930 each have a depth component that corresponds to a pixel depth within the graphical scene 150.*", *in which a selected rendering algorithm, such as ray casting or ray bundle casting, is performed with respect to the position of the rays, whether in an individual or bundled position for pixels, that thereby reside within a two dimensional image*). Therefore it would have been obvious to one skilled in the art at the time of invention to modify the volume rendering of Argiro and contributing pixel values of Kaufman with the selected rendering parameters of Buehler because this modification would enable efficient rendering of a volume data set through providing particular rendering parameters based on certain positions of the ray as is traverse through data, thereby improving rendering accuracy of the data traversed by the ray by enabling parameters of the rendering to be provided in response to the position of the ray.

Regarding claim 21, Argiro and Kaufman fail to teach wherein the selected one of the plurality of rendering algorithms/parameters changes with the ray position. Buehler teaches wherein the selected one of the plurality of rendering algorithms/parameters changes with the ray position (¶0143 lines 1-2: "*The bundle caster 910 recursively advances a position 914 of a ray bundle.*", ¶0144 lines 1-4: "*...the bundle caster provides an individual ray 912 to the ray caster 930.*" and ¶0145 lines 5-8: "*...position 914 that is advanced by the bundle caster 910 and the position 932 that is advanced by the ray caster 930 each have a depth component that corresponds to a pixel depth within the graphical scene 150.*", *in which a selected rendering algorithm, such as ray casting or ray bundle casting, is performed with respect to the position of the rays, whether in an individual or bundled position for pixels, that thereby reside within a two dimensional image*). Therefore it would have been obvious to one skilled in the art at the time of invention to modify the volume rendering of Argiro and contributing pixel values of Kaufman with the selected rendering parameters of Buehler because this modification would enable efficient rendering of a volume data set through providing particular rendering parameters based on certain positions of the ray as is traverse through data, thereby improving rendering accuracy of the data traversed by the ray by enabling parameters of the rendering to be provided in response to the position of the ray.

Allowable Subject Matter

Claims 4, 9, 12 and 15-20 are objected to as being dependent upon a rejected base claim, but would be allowable if rewritten in independent form including all of the limitations of the base claim and any intervening claims.

The following is a statement of reasons for the indication of allowable subject matter: In regards to claim 6, the prior art fails to teach a system for visualizing a three-dimensional (hereinafter "3D") volume, in particular for medical applications; the system including: an input for receiving a three-dimensional set of data representing voxel values of the 3D image; a storage for storing the data set; an output for providing pixel values of a two-dimensional (hereinafter "2D") image for rendering; and a processor for, under control of a computer program, processing the data set to obtain a 2-dimensional representation of the volume by projecting the volume onto an imaginary 2D projection screen from a predetermined viewpoint by for each pixel of the 2D projection image: casting a ray from the viewpoint through the pixel and through the volume; traversing along the ray through at least a plurality of ray positions within the volume under control of a protocol that determines a rendering algorithm and/or rendering parameters in dependence on the ray position with the determined rendering algorithms and/or rendering parameters being different for some ray positions than the determined rendering algorithms and/or rendering parameters for other ray positions; and for each of the plurality of ray positions using a corresponding one of the determined rendering algorithm/parameters to calculate a contribution to a pixel value of the pixel based on at least one voxel value with a predetermined range of ray positions, wherein the protocol is rule-based; wherein a rule prescribes for each of the plurality of ray positions at least one processing action at least in dependence on processing

results of ray position along the ray that already been processed wherein the processing action includes at least one of the following: jumping forward or backward along a ray to a particular ray position, and resuming processing from that position; switching a stepping direction along a ray between forward and backward as seen from the viewpoint; changing a step size that determines a next ray position with respect to a current ray position in the stepping direction; changing a 3-dimensional direction of a ray starting from a particular position; switching to another rendering algorithm; adapting rendering parameters for controlling the rendering algorithm; switching to another feature detection method, which determines the type of information that is going to be visualized by the rendering algorithm, therefore claim 6 is allowable.

Response to Arguments

Applicant's arguments filed 12/22/09 have been fully considered but they are not persuasive.

The applicant argues that the rendering method of Buehler does not change from ray to ray, and that all rays are cast using the same algorithm. However, the applicant's arguments are unpersuasive in view of the rendering methods of Buehler which change from ray to ray based on whether the ray resides within a ray bundle, or has an individual position (¶0143 lines 1-2 and ¶0144 lines 1-4).

The applicant's arguments in view of claim 14 have been considered, but are moot in view of the new grounds of rejection presented in the above office action.

Conclusion

Any inquiry concerning this communication or earlier communications from the examiner should be directed to SAID BROOME whose telephone number is (571)272-2931. The examiner can normally be reached on M-F 8:30am-5pm.

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Ulka Chauhan can be reached on (571)272-7782. The fax phone number for the organization where this application or proceeding is assigned is 571-273-8300.

Information regarding the status of an application may be obtained from the Patent Application Information Retrieval (PAIR) system. Status information for published applications may be obtained from either Private PAIR or Public PAIR. Status information for unpublished applications is available through Private PAIR only. For more information about the PAIR system, see http://pair-direct.uspto.gov. Should you have questions on access to the Private PAIR system, contact the Electronic Business Center (EBC) at 866-217-9197 (toll-free). If you would like assistance from a USPTO Customer Service Representative or access to the automated information system, call 800-786-9199 (IN USA OR CANADA) or 571-272-1000.

/Said Broome/
Examiner, Art Unit 2628